Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Parts 1, 2, 22, 24, 27, 90 and 95 of	)	WT Docket No. 10-4
The Commission's Rules to Improve Wireless	)	
Coverage Through the use of Signal Boosters	)	
	)	

COMMENTS ON NOTICE OF PROPOSED RULEMAKING

July 23, 2011

I. COMPANY BACKGROUND

TriPower Group Corporate Overview

Tri-Power Group is a privately-held technical services company headquartered in Livermore, CA. TriPower is one of west coast's largest and one of the most experienced systems integrators providing in-building public safety and cellular coverage throughout the United States. TriPower has earned the reputation of delivering high quality public safety grade DAS systems in hospitals, jails, police facilities, casinos, condominiums, apartments and other enterprise projects.

Since 2000, Tri-Power Group has been assisting wireless carriers, public safety officials, building owners, corporate enterprises, and other constituents create systems that provide seamless and robust wireless coverage. Some of Tri-Power Groups credentials include:

- More than 1200 wireless DAS implementations
- Over 1800 wireless system designs and propagation analysis
- Current installations provide over 200 million square feet of wireless coverage
- Currently approximately 85% of all TriPower DAS implementations either support a public safety entity, were driven by either public safety ordinance or were implemented to support public safety entity directly

TriPower reference projects

- City of Los Angeles; Metro Detention Center
- County of Riverside; Smith Correctional Facility
- State of Utah; Utah State Capitol Building
- City of Mesa; Mesa Art Center
- Phoenix Children's Hospital
- Kaiser Hospitals throughout Northern CA.
- Kemper Development Company; Bellevue Washington
- Bay Area Rapid Transit District
- Stanford Linear Accelerator Tunnels

TriPower has designed and delivered systems using the following manufactures equipment;

- Mobile Access (Fiber DAS)
- Solid Technologies (Public Safety Grade fiber DAS)
- LGC Wireless (Fiber DAS)
- Andrew (Indoor/Outdoor Fiber DAS)
- PowerWave (Fiber DAS)
- ADRF (BDA)
- Rtron (BDA)
- CSI (BDA)
- TX/RX (Public Safety Grade BDA)
- Dekolink (BDA)

TriPower's three member Executive Engineering staff has a combined 63 years of Military and Public Safety Communications design experience. Gregory Glenn, Director of RF Engineering also works closely with public safety grade BDA and DAS vendors here in the United States and abroad. Mr. Glenn conducts seminars nationwide for APCO and others who wish to understand DAS systems from a very basic level through component and engineering level. He has been published in Public Safety Communications magazine on this very subject.

II. Executive Summary

While we applaud the Commission for initiating this proceeding to empower consumers with the ability to purchase and deploy well-designed and properly installed signal boosters. It is important for the Commission to clearly define “well designed” as well as “properly installed”.

With respect to Part 90 Private Land Mobile signal boosters, the commission seeks to revise technical and operational requirements for these devices, but it should be understood that much of the BDA interference caused to the public safety Part 90 users is in fact created by amplifiers designed to operate in the Part 22 cellular portion of the 800 band. As stated by several parties it should be understood that the broadband amplifiers used by Sprint/Nextel also produce much of BDA interference problems experienced by the public safety Part 90 user.

It should also be recognized that many of the Part 22 and Part 90 carriers create their own problems due to the products that they approve to be used within their networks. Just because equipment is FCC type accepted does not mean it is good for the network. Verizon for instance, has approved a “Install it yourself” small DAS system, that if one were to read the actual specification and do a little math would see that the product has a very good chance of self-oscillation due to its inherent design. It should also be recognized that most carrier labs do nothing within their test procedures to determine how a particular product might affect an adjacent band user; I.E. through the generation of intermodulation or thermal noise products that fall out of band.

While TriPower group designs, implements and maintains “in building” signal distribution systems used by most major carriers and as well as public safety users throughout the United States, we have no issues with the Commission’s desire to provide access to reliable low cost in building signal enhancement devices. We furthermore do not take exception with the practices the carriers use in accepting DAS equipment on their networks.

TriPower’s only concern is when the use of these products affects the Part 90 **public safety users** south of the 49th parallel, which in this situation would be the users licensed between the **851 – 869/806 – 824 MHz** portion of the RF spectrum.

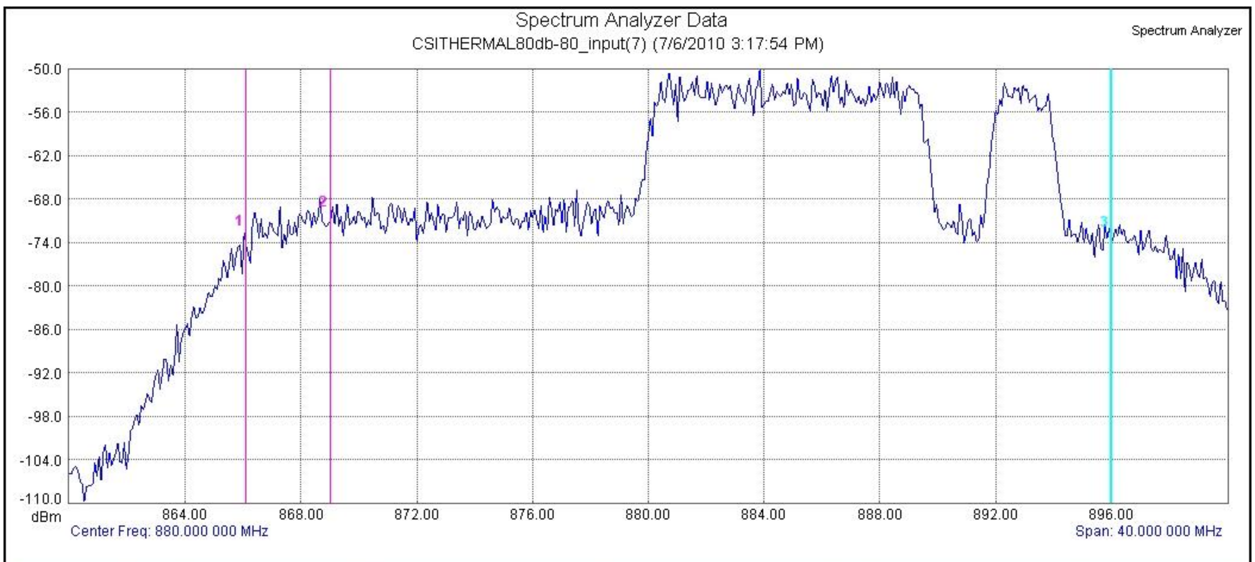
TriPower will demonstrate through the use of test results and mathematical models that the existing specifications used by the Commission for the technical acceptance of BDA and DAS equipment is lacking and should be updated. Under the existing rules, part 22 and part 90 BDA/DAS equipment can causes hardship to public safety users. TriPower will also lay out some suggested specifications to make sure the public safety user will not realize any impact on their communications systems as a result of poorly engineered product that may be operating within the 850 MHz US cellular band (Part 22) nor the 850 MHz US SMR band (Part 90).

III. Comments

The comments in the body below are in response to FCC Document FCC 11-53 WT Docket 10-4.

Part 22 Amplification Systems

Let us look first at how Part 22, cellular amplifiers are affecting the Part 90 public safety user. Figure A is a spectrum sweep of a popular Part 22 – 800 MHz carrier grade Bi Directional Amplifier (BDA).



Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	☐	☐	866.078 0 MHz	-73.77 dBm	- -	- -
2	☐	☐	869.000 0 MHz	-71.13 dBm	- -	- -
3	■	☐	896.016 4 MHz	-73.92 dBm	- -	- -
4	☐	☐	- -	- -	- -	- -
5	☐	☐	- -	- -	- -	- -
6	☐	☐	- -	- -	- -	- -

Measurement Parameters

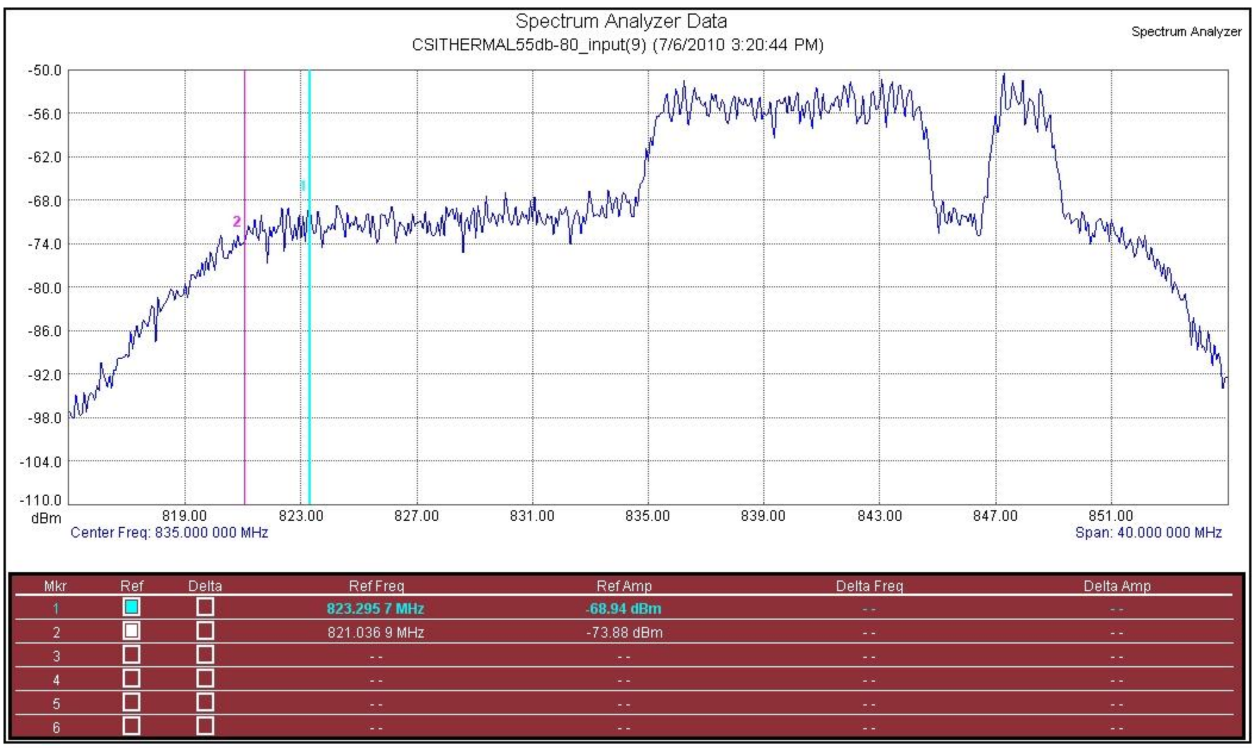
		Stop Frequency	900.000 000 MHz
Trace Mode	Normal	Frequency Span	40.000 000 MHz
Preamp	OFF	Reference Level	-30.000 dBm
Min Sweep Time	0.001 S	Scale	10.0 dB/div
Reference Level Offset	0.0 dB	Operator Name	
Input Attenuation	0.0 dB	Tower	
RBW	10.0 kHz	Serial Number	749086
VBW	3.0 kHz	Base Ver.	V3.10
Detection	RMS	App Ver.	V4.21
Center Frequency	880.000 000 MHz	Date	7/6/2010 3:17:54 PM
Start Frequency	860.000 000 MHz	Device Name	

Figure A

This particular amplifier is widely used throughout the industry. In this particular instance this amplifier was affecting a 900 MHz SMR system on the same roof top.

As can be seen clearly this amplifier is generating thermal noise well outside of its operational band. While this amplifier is designed to pass 869 to 896 one can see that the mechanical filter rolls off very slowly with thermal noise products just starting to roll off at 866 MHz, well into the **upper NPSPAC** portion of the SMR band. It should also be noted that while this amplifier has a DSP, most third order intermodulation products are produced in the final PA stage of the amplifier. These inter-modulation products are typically removed by a good mechanical filter. Under the current rules spurious products can be emitted from this amplifier at a level of -13 dBm. It is clear by this spectrum presentation that this amplifier can produce 3rd order products well into the **upper NPSPAC** portion of the SMR band.

Even more alarming is the spectrum analyzer sweep in the figure below. Figure B is the same **FCC type accepted and carrier approved amplifier**. This is a spectrum shot of the uplink side of the amplifier. This is the thermal noise that is being spewed into the **outside** world. Noise generated on the reverse link or uplink emitted from the donor antenna on top of the roof.



Measurement Parameters

		Stop Frequency	855.000 000 MHz
Trace Mode	Normal	Frequency Span	40.000 000 MHz
Preamp	OFF	Reference Level	-30.000 dBm
Min Sweep Time	0.001 S	Scale	10.0 dB/div
Reference Level Offset	0.0 dB	Operator Name	
Input Attenuation	0.0 dB	Tower	
RBW	10.0 kHz	Serial Number	749086
VBW	3.0 kHz	Base Ver.	V3.10
Detection	RMS	App Ver.	V4.21
Center Frequency	835.000 000 MHz	Date	7/6/2010 3:20:44 PM
Start Frequency	815.000 000 MHz	Device Name	

Figure B

Again note this amplifier incorporates a DSP to create the pass bands. It also incorporates a rather weak mechanical filter that does a less than adequate job of filtering the thermal noise created by the power amplifier(s).

The average noise level power radiated outside of the DSP filter windows and within the mechanical (area between marker 1 and marker 2 in figure B) pass band is approximately -69 dBm. This noise extends well down **below** the Part 22 cellular band, **well into the NPSPAC** portion of the Part 90 SMR band. Assuming this amplifier is connected to an 11 dB gain antenna with a 2 dB cable loss (-69+11-2) the thermal noise power radiating from the donor antenna is approximately -60 dBm. (Spectrum presentation using a 10 KHz resolution bandwidth)

While thermal noise is something we live with on a day to day basis it does not appear that its affects have been discussed. A BDA or DAS will always amplify thermal noise even when it is sitting idle. Thermal or Johnson- Nyquist noise is the electronic noise generated by the agitation of electrons within a conductor. Thermal noise also exhibits a relatively equal power throughout the spectrum. In other words it exists by nature.

Thermal noise was first measured by John Johnson and modeled by Harry Nyquist of Bell Labs in 1928. It is generally accepted that thermal noise at room temperature is -174 dBm / HZ. In a 10 KHz channel -174 + 10(10000) = -134 dBm.

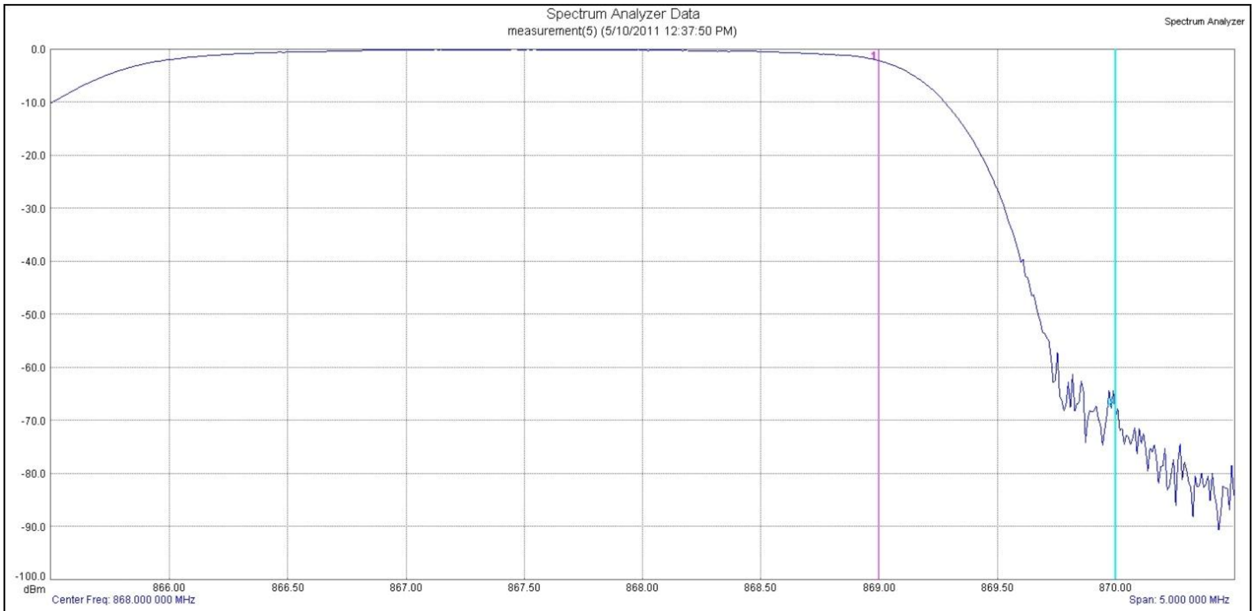
Public safety users operate their base station systems in what is considered a noise limited environment. This means they do not reuse channels as the cellular operators do; therefore a base station receiver's ability to receive a signal is limited by thermal noise.

When a radio signal leaves an antenna it is affected by loss as the signal travels through the atmosphere. This loss has also been modeled at it is generally accepted that for every doubling of distance the signal will decay by 6 dB. The accepted formula for free space loss calculations is FSL = 20* log (F) + 20 log (D) + 36.6.
Where;
F = frequency in MHz
D= distance in Miles

Now take the amplifier in figure B. The thermal noise generated by the amplifier at the antenna is approximately -60 dBm. A bit of simple math would indicate that the thermal noise from this amplifier will be seen at a receiver site at 450 feet away, and this is assuming no gain at the base station antenna. A public safety base station with an antenna gain of 12 dB would see effects from this amplifier at greater than 1800 feet away. This is a relatively quiet amplifier but it can impact a system in metropolitan area.

One might argue that this is not important, but consider this; if a public safety receiver site is designed to cover a 7 mile radius and the noise floor is raised 6 dB the site will now only cover an area of 3.5 miles. If one looks at the coverage loss in square miles at 7 mile radius the site covers 154 square miles. At 3.5 mile radius the site covers 38 square miles. That is a loss of 116 square miles or 75%.

Below you will find test equipment sweeps of readily available filters used by responsible integrators and manufacturers deploying public safety part 90 systems. These filters are used to protect cellular part 22 users. Using a filter with the same response curve on a part 22 amplifier would virtually eliminate any uplink noise problems to the public safety user. This type of filter also greatly curtails any third or fifth order products that may be present in the power amplifier output.



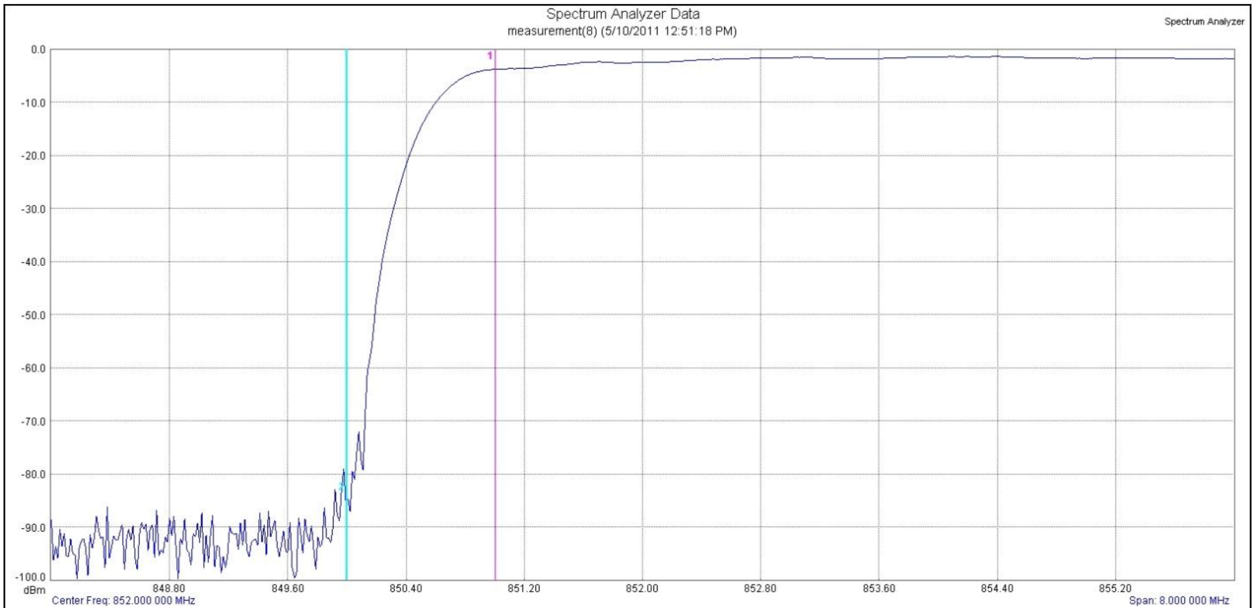
Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	☐	☐	869.000 0 MHz	-2.14 dBm	- -	- -
2	☐	☐	870.000 0 MHz	-69.35 dBm	- -	- -
3	☐	☐	- -	- -	- -	- -
4	☐	☐	- -	- -	- -	- -
5	☐	☐	- -	- -	- -	- -
6	☐	☐	- -	- -	- -	- -

Measurement Parameters

		Stop Frequency	870.500 000 MHz
Trace Mode	Normal	Frequency Span	5.000 000 MHz
Preamp	OFF	Reference Level	-20.000 dBm
Min Sweep Time	0.001 S	Scale	10.0 dB/div
Reference Level Offset	-20.0 dB	Operator Name	
Input Attenuation	0.0 dB	Tower	
RBW	10.0 kHz	Serial Number	749086
VBW	3.0 kHz	Base Ver.	V3.10
Detection	Sample	App Ver.	V4.21
Center Frequency	868.000 000 MHz	Date	5/10/2011 12:37:50 PM
Start Frequency	865.500 000 MHz	Device Name	

Figure C

Figure C shows the output filter response of a **NPSPAC** filter commonly used by the public safety community. Note the sharp skirt. This filter accomplishes a 66 dB roll-off at 1 MHz beyond the band edge. Implementing this filter the thermal noise level 1 MHz out of band would be virtually non-existent.



Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	☐	☐	851.000 0 MHz	-3.78 dBm	- -	- -
2	■	☐	850.000 0 MHz	-85.21 dBm	- -	- -
3	☐	☐	- -	- -	- -	- -
4	☐	☐	- -	- -	- -	- -
5	☐	☐	- -	- -	- -	- -
6	☐	☐	- -	- -	- -	- -

Measurement Parameters

		Stop Frequency	856.000 000 MHz
Trace Mode	Normal	Frequency Span	8.000 000 MHz
Preamp	OFF	Reference Level	-20.000 dBm
Min Sweep Time	0.001 S	Scale	10.0 dB/div
Reference Level Offset	-20.0 dB	Operator Name	
Input Attenuation	0.0 dB	Tower	
RBW	3.0 kHz	Serial Number	749086
VBW	1.0 kHz	Base Ver.	V3.10
Detection	Sample	App Ver.	V4.21
Center Frequency	852.000 000 MHz	Date	5/10/2011 12:51:18 PM
Start Frequency	848.000 000 MHz	Device Name	

Figure D

Figure D shows the output filter response of another filter set commonly used by **public safety** DAS integrator to protect the **cellular uplink** side of the 800 MHz band. Note the roll off of this filter is about 82 dB at 1 MHz outside of its designed pass band.

While it may not be necessary to use this quality of filter on a consumer based amplifier we believe that the Commission should set some new standards as to hum, noise and spurious emissions as it pertains to part 22 amplifiers generating noise into the part 90 portion of the band as well as part 90 amplifiers generating noises into the part 22 portion of the 800 MHz band. TriPower believes that rather than stating filter responses the Commission should adopt an ERP power level that **shall not be exceeded**. This allows for manufactures and integrators the flexibility to use whatever means necessary to meet these standards. (DSP, mechanical, or ceramic filter etc.)

TriPower would suggest that the ERP generated by any amplifier 1 MHz off of its designed service band be no greater than -**75 dBm ERP** (as read using a spectrum analyzer or power meter with a 10 KHz resolution bandwidth) for both noise and intermodulation products. This rule should be adopted for all amplification units BDA or DAS component. Math calculations would indicated that on the downlink or forward link side that any thermal noise or intermodulation products generated by a **part 22-800 MHz** cellular amplifier within the **part 90 portion of the 800 MHz** band (noise below 868 MHz) will produce a signal no greater than -115 dBm on any given floor at 10 foot off of the service antenna (assuming unity gain). This will prevent the addition of **Part 22** cellular amplification systems from raising the noise floor within a building to a point where a **-95 dBm** signal level from the **Part 90 public safety** system is no longer effective to carry out public safety communications. This also protects the public safety base station receive sites from noise rise due to thermal noise/intermodulation generation on the uplink/reverse link side. By implementing this type of rule integrators and manufactures have the flexibility to use the antenna/filter combinations necessary to meet these specifications.

TriPower would suggest that the same specifications be used for **Part 90** amplifiers as they cross into **Part 22** territory.

Some may argue that the **public safety users** will be moved down to the lower portion of the part 90 band. Today, many still use the 866-869 portion of the band and Sprint has again requested an extension to complete the re-banding process. Because of this it is still important to protect the **part 90 public safety** users in the upper NPSPAC (866-869 MHz) portion as well as lower (851-854 MHz) of the band.

A mobile consumer grade amplifier (**Part 22 or 90 or 95**) should be able to meet these goals as they will have relatively low gain and low power output.

Part 90 amplification systems

In regards to **Part 90** amplification systems we believe that amplification systems should be looked at on a case by case basis until re-banding is completed. Sprint discusses problems involving - 800 MHz amplifiers used by public safety[1] ; TriPower is unaware of any amplifier approved by Sprint that protects the public safety user operating in the upper NPSPAC band. TriPower would argue that most responsible integrators **are** using amplification systems that use only the pass bands necessary to support the **public safety user**. For instance all of the amplifiers that TriPower installs in markets such as Seattle, Phoenix and Southern California are designed with post Power Amplifier filters designed **not to pass** the **861-866 MHz** downlink or the **816-821 MHz** uplink portion of the **Part 90 band**. In applications that only require upper NPSPAC or lower NPSPAC (post re-banding NPSPAC) TriPower incorporates 3 MHz windows on all of its amplifiers with very sharp roll off characteristics post power amplifier.

Until re-banding is complete we believe that all **Part 90** systems should be coordinated on both sides as stated by Jack Daniel.[2] We also agree with comments made by Potter as well as well.[3]

Once re-banding is completed or in any market where re-banding has been completed we would suggest that any amplifier used by Sprint to support its **Part 90 carrier** operation meet the same requirements as stated for the **Part 22** - 800 MHz BDA/DAS amplifiers, where any noise product 1 MHz above or below the designed pass band of the amplifier be no greater than **-75dBm** ERP (as measured with power meter or spectrum analyzer channel power within a 10 KHz bandwidth + antenna gains). This would virtually eliminate any uplink interference as well as downlink noise floor rise to **part 90 public safety users** while allowing the use of high gain amplifiers as are in use currently by Sprint.

[1] FCC 11-53, released April 6, 2011; page 8, paragraph 18
[2] FCC 11-53, released April 6, 1011; pages 8 and 9
[3] FCC 11-53, released April 6,2011; pages 19 and 20 paragraphs 51 and 52

Amplifier Classification

TriPower questions the use of amplifier classifications of **Class A** and **B** type signal boosters. With the Commission moving to a 6.25 KHz channel spacing in the **Part 90** spectrum, today's **class A** signal booster will become tomorrow's **class B** signal booster. TriPower supports the use of good engineering practices to avoid the pitfalls of poorly designed systems. Most complaints leveled against so called **Class B** signal boosters are due to poor filter designs and the same problems exist in today's **Part 22 DSP** based amplifiers as noted above. **Class A** signal boosters have the potential to cause harmful interference as well as **Class B**. In TriPower's experience most interference problems are caused by poor filtering at the output of high power amplifier (HPA) stage. Thermal noise and harmonic products that are created in the HPA are not being properly filtered thus create noise outside of band of design. TriPower also questions the use of amplifiers (DAS or BDA) that have filter characteristics that have pass bands less than 150 KHz. When filter pass-bands of less than 150 KHz are implemented time delays increases. Time Domain Interference can be as harmful to the operation of any public safety system, much more so than amplifying adjacent channels with broader filter. In fact in most situations there is absolutely no harm in amplifying an adjacent channel and may be preferable. TriPower contends that the time delay problem associated with narrow pass band, so called "**Class A**" amplifiers cause enough problems that the operational bandwidth is widened to the point where the "**Class A**" amplifier actually passes more than one channel thus becomes a "**Class B**" amplifier. TriPower also contends that in order to combat the time domain (time delay issue) that manufactures claim to be "**Class A**" but in reality the skirts of the filters are so broad that a 25 KHz filter in reality passes almost 75 KHz.

TriPower suggest that the Commission drop the **Class A** and **B** designators all together as they are **in practice**, irrelevant. If the Commission elects not to drop the **Class A and B** amplifier designation we ask that the Commission define the filter response curve or channel mask that will constitute a **Class A** amplifier. Unfortunately, the Class designator has been used by some to **confuse** the market place.

IV. Summary

While the Commission is looking to provide low cost alternatives for consumer grade signal boosters it appears that the Commission is correctly looking at the Signal Booster/DAS issue in a more macro sense. As the industry becomes more converged where by multiple carriers are placing systems within the same buildings it is important to look at the issue on a large scale basis. By implementing some of the ideas outlined above the Commission can greatly enhance the user experience for all parties involved. Consumers will be able to purchase low cost alternatives for signal boosters and interference to carriers and public safety users will be greatly reduced.

Respectfully Submitted,

Gregory M. Glenn
Director of RF Engineering
TriPower Group.